THE BORN RULE AND FREE WILL: WHY LIBERTARIAN AGENT-CAUSAL FREE WILL IS NOT "ANTISCIENTIFIC"

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Abstract. In the libertarian "agent causation" view of free will, free choices are attributable only to the choosing agent, as opposed to a specific cause or causes outside the agent. An often-repeated claim in the philosophical literature on free will is that agent causation necessarily implies lawlessness, and is therefore "antiscientific." That claim is critiqued and it is argued, on the contrary, that the volitional powers of a free agent need not be viewed as anomic, specifically with regard to the quantum statistical law (the Born Rule). Assumptions about the role and nature of causation, taken as bearing on volitional agency, are examined and found inadequate to the task. Finally, it is suggested that quantum theory may constitute precisely the sort of theory required for a nomic grounding of libertarian free will.

Born Rule; free will; anomic action

1. The Born Rule and Free Choices

The *agent causation* (AC) theory of free will holds that truly free human choices are attributable not to specific events or causes external to a choosing agent, nor to desires or other internal psychological influences, but only to the volitional power of the choosing agent. In effect, that is what "volition" means according to AC. But the latter is currently a minority view. The more "mainstream," conservative approach to the problem of free will is to assert that "free will" simply means acting in accordance with our desires in a way that is free of external constraints. This view is called *compatibilism*, because it was developed specifically to be compatible with deterministic laws. In effect, it defines the term "free will' in such a way that we can say we are making free choices as to how to behave even when all of our behaviors are fully determined by past causes and inexorable deterministic laws (or even fated in the sense of being elements of a "block world" in which the future exists in the same way as the past and present). In contrast, AC is a form of *incompatibilism*, which denies that free will is compatible with determinism. It holds that in order for us to have free will, the world must be fundamentally indeterministic. AC is the *libertarian* form of incompatibilism; it asserts that the world is in fact indeterministic, and that we do have free will. Our own volitional power is taken as the primary cause of our choices. The complementary form of incompatibilism is to assert that the world is deterministic and therefore to deny that we have free will.

It is often asserted that the agent causation view requires lawlessness, and is necessarily "antiscientific." For example, the entry on incompatibilism in the Stanford Encyclopedia

of Philosophy states: "Libertarians who hold this view [agent causation] are committed, it seems, to the claim that free will is possible only at worlds that are at least partly lawless, and that our world is such a world." [1]

Sider [2] argues that this alleged incompatibility of agent causation with scientific laws extends beyond ordinary deterministic laws to the indeterministic probability law (i.e. the Born Rule) of quantum theory. He briefly entertains the idea that agent causation could 'peacefully coexist' with an indeterministic law such as the Born Rule, concluding in the negative, as follows:

In the previous sections I was ignoring quantum mechanics. For instance, I was assuming that if a cause occurs, its effect must occur, even though quantum mechanics merely says that causes make their effects probable. Why did I ignore quantum mechanics? Because randomness is not freedom...A libertarian might concede that randomness is not sufficient for freedom, but nevertheless claim that quantum randomness makes room for freedom, because it makes room for agent causation. Imagine that it is 1939, and Hitler has not yet decided to invade Poland. He is trying to decide what to do among the following three options:

Invade Poland
Invade France
Stop being such an evil guy and become a ballet dancer

Quantum mechanics assigns probabilities to each of these possible decisions; it does not say which one Hitler will choose. Suppose, for the sake of argument, that the probabilities are as follows:

95% Invade Poland
4.9% Invade France
0.1% become a ballet dancer

If this picture [of quantum theory leaving room for free will] were correct, then my criticism of libertarianism as being anti-scientific would be rebutted: agent causation could peacefully coexist with quantum mechanics. In fact, though, the coexistence picture makes agent causation a slave to quantum-mechanical probabilities." (p. 124)

In other words, Sider assumes that Hitler, as modeled above, must 'mindlessly follow the probabilities' and therefore is not really free to choose. (Sider 2005, p. 125)

On the next page, he concludes:

"Quantum mechanics does not help the agent-causation theorist. I will now go back to ignoring quantum mechanics. "(p. 125)

However, Sider's formulation depends on the highly nontrivial but unsupported claim that a human agent can be represented as a quantum system with a well-defined state over the relevant time period, and that the agent's choices can be characterized by eigenvalues of an operator represented the set of options available to the agent. So, for example, if the agent (Hitler) is presented with a choice of actions, the measured operator is assumed to be one whose possible outcomes (eigenvalues) are "Invade Poland, Invade France, or Become Ballet Dancer." Then the Born probabilities for measurement outcomes are assumed to apply to those possible actions, considered as eigenstates, conditioned on the presumed stable-over-time initial quantum state of the choosing agent. It then follows, so the argument goes, that an agent would be a "slave" to those quantum statistics in order to be in compliance with the Born Rule. If not a slave, then the agent would presumably be able to violate the rule willy-nilly, and thus be in engaging in anti-scientific, "anomic action."[1]

The main purpose of this paper is to argue that this argument fails because a human agent cannot be assumed to be modeled in this way.[2] First, however, I will note some objections of Clarke [4] to the claim that libertarian free will must be inconsistent not only with deterministic laws but also with statistical laws such as the Born Rule. Clarke argues against this claim by noting that:

probabilistic laws of nature also do not require, for any finite number of trials, any precise distribution of outcomes. The probabilities involved in diachronic laws...are the chances that events of one type will cause, or will be followed by, events of another type. ... These probabilities, we may assume, determine single-case, objective probabilities, or propensities. Actual distributions can diverge from proportions matching these probabilities. As trials of some process governed by such a law increase, it becomes increasingly likely that the distribution of outcomes will match the probabilities given by the laws. But for any finite number of repetitions, any distribution at all is possible for outcomes neither determined to occur nor determined not to occur. (390-1)

[1] Technically, to say a set of events is 'anomic' is not a statement about law violation, but about the fact the events are not covered by any law. But clearly, if a set of events is not covered by any law whatsoever, than any given extant law must be violated by them; that is, the set of events must fail to conform to that law. Thus it follows that the claim that actions of free will are anomic is equivalent to the claim that events resulting from such actions would have to violate any extant law. For otherwise they would be consistent with that law, and would therefore fail to be anomic.

[2] Pereboom similarly claims that "...although our being undetermined agent-causes has not been ruled out as a coherent possibility, it is not credible given our best physical theories." ([3], 422) By this, he presumably endorses Sider's argument.

Thus, a statistical law is not violated unless very large numbers of precisely repeated experimental runs yield statistically significant deviations from expected mean values, where even "statistically significant' can be a matter of context and degree. Highly unlikely strings of outcomes may occur, and yet a statistical law may still not be violated. The point here is that the demonstration of a violation of a statistical law requires a high hurdle of empirical evidence.

Clarke presents an example in which an agent may "freely choose to obey the laws" by choosing to obtain a distribution of choice outcomes that comport with a prescribed probabilistic law in a psychology experiment. He notes that each of the agent's individual choices are free, even in the face of such a law. This author concurs that the situation envisioned in this example bears against the idea that an agent with libertarian free will must necessarily violate statistical laws. However, one might still wonder whether an agent governed not by an arbitrary statistical law but by the laws of quantum mechanics might somehow be constrained by them in a way that would either void his causal agency or necessarily violate the laws of quantum mechanics; i.e., by resulting in observable deviations from the Born Rule. It is this situation that is considered herein.

Concerning the Born Rule, the first thing to note is that in order to predict physically relevant probabilities of outcomes with the Rule, one must have a clearly defined system and a clearly defined observable being measured on that system. A system definition must be able to state how many degrees of freedom (usually considered as 'particles') are in play, and exactly what the initial state of that system is. An observable definition must be able to state exactly what forces are acting on the system and what sort of detection process constitutes the outcome of the observable being measured. These requirements may be straightforwardly met for microscopic systems in the laboratory, but it is a highly nontrivial matter as to whether they may be met under conditions obtaining in the context of human behavior.

Now, consider Sider's apparent assumption that a human agent, if truly free, should be able to make choices that would deviate from the Born Rule (for otherwise he would be a 'slave' to the rule and thus not be making free choices). Such a claim assumes that one could set up repeatable experiments in which the agent could be precisely defined as a quantum system in an unambiguous quantum state, whose applicable observable was also tightly enough defined so as to be able to detect such deviations. It is only if such deviations were in principle detectable that there could be a violation from the statistical laws of quantum mechanics, as observed in Clarke's remark quoted above. However, there are very good reasons to think that this is not the case.

For one thing, as noted above, one has to be able to perform precisely repeatable experiments. Does exposing a given human agent to repeated opportunities to make a choice constitute a precisely repeatable experiment of this type? Almost certainly not. The human agent is an open system, continually exposed to variable influences from his or her environment: air currents, radiant energy, etc; as well to internal fluctuations (number

of blood cells in the brain, number of activated neurons, etc.). Assuming the brain is the most relevant bodily system concerning the choice, the state(s) and the number of relevant degrees of freedom in the brain are in continual flux. There is no justification for assuming that the agent would be in the same quantum state over any extended period of time, in particular the time interval in which repeated choices would be presented. No matter how tightly one might attempt to control the agent's environment, one is dealing with an enormously complex and under-defined system, from a quantum- mechanical perspective.

It we want to be more careful in the application of physical law, the example of Hitler facing different choices of action is better modeled as a macroscopic system with several possible macrostates, where the macrostates correspond to the choices. Each such macrostate is instantiated by an enormous number of microstates (we will see just how enormous in what follows). It is only at the level of the microstates that quantum laws would become relevant, not at the level of the macroscopic system of "Hitler's body and brain." So the choice discussed by Sider would more accurately be described by probabilities dictated by the Gibbs ensembles of statistical mechanics, not the Born Rule. However, quantum effects could be relevant at the level of individual microstates, such that quantum indeterminism might enter at that point.

Thus, there is indeed an entry for fundamental indeterminism allowing in principle for free will, but not in such a way that it would lead to observable Born Rule or other law violations. One can see this by noting that the number of microstates corresponding to a sample of ice in a macrostate defined by a temperature of 273K and normal atmospheric pressure is roughly $10^{1,299,,000,000,000,000,000,000,000}$. (This is calculated using $S = klogW$, where S is the system's entropy, k is Boltzmann's thermodynamic constant, and W is the number of microstates corresponding to a given macrostate; and the experimentally determined value of S for the given ice macrostate is input.[1]) This is the number of microscopic (quantum-level) different possible configurations of the atoms in the ice that give rise to exactly the same outward, classically observable properties for the sample. (Just for comparison, the number of atoms in the entire universe is estimated to be "only" about 10^{80}.) Given that the body and brain are largely composed of water, the number of microstates involved in describing macroscopic human behaviorial states is of the same astonishing order.

Now suppose a human being could exercise free will by volitionally altering some of the microstates in his brain, exploiting quantum indeterminacy. Granted, this would require that the brain's neural wiring be delicately balanced so as to be able to manifest such alterations as changes in the relevant macrostates. But as a human brain is a far-from equilibrium biological system, this is certainly a conceivable brain function. Could one detect any Born Rule violation as a result of this process? In order to do so, one

[1]Details are given by Lambert [5] at http://entropysite.oxy.edu/microstate/, where it is noted concerning this enormous number of microstates that "Writing 5,000 zeroes per page, it would take not just reams of paper, not just reams piled miles high, but light years high of reams of paper to list all those microstates!"

would have to have exactly repeatable input/measurement/output data; that is, one would have to have data demonstrating that specific neural atoms or molecules underwent state transitions at rates not in conformity with the rule. Even if this were in principle possible, the number of microstates that would have to be taken into account would, as above, be hyper-astronomical. At the rate of recording even one microstate's atomic transitions per second (way too optimistic to be realistic), this would take hugely longer than the age of the universe. Clearly, the model of Hitler and his putative quantum choice-eigenstates is grossly oversimplified.

The example of mental activity influencing a choice raises another important consideration: if we are going to discuss the relevance of quantum indeterminism for free will, we must take into account whether it should be understood as describing only physical/material systems, or whether in some way it also pertains to mental activity. Now, a physicalist would deny that the mind is anything different from the physical brain, and an idealist would assert that quantum mechanics describes mental substance in various guises, among them apparently solid matter. Meanwhile, a dualist would presumably say that physical theory describes only material substance and therefore mind is not addressed by quantum theory. The very fact that there are very different metaphysical views concerning the nature of matter and mind, and the role of either substance in explaining and understanding human behavior, dictates that we must tread with extreme caution when invoking physical theories (whether presumed deterministic or not) as a basis to argue either for or against the existence of free will.

Against this backdrop, it would seem reasonable to point out, with prudence, at least the possibility that quantum indeterminism might provide an opening for free will–if only as an avenue of possible escape from the alleged 'fatedeness' of future actions. To rule out that possibility based on a demonstrably oversimplified application of quantum laws to choices modeled as quantum observables and human beings ostensibly labeled by stable-over-time quantum states would seem to be precipitous.

Even assuming that one could model human choices directly by quantum states corresponding one-to-one with specific choices (as opposed to taking into account the macrostate/microstate relationship), the crucial point is that at the level of individual instances the Born Rule gives only propensities for outcomes. [1] A human agent described as a huge quantum system might instantaneously be subject to those propensities yet, given quantum indeterminism, still have room to make a free choice (in the sense that the choice is made by the agent as a volitional, primary substance). If another instance outwardly presenting the same choice came before the agent, it is in fact overwhelmingly unlikely that the agent is in exactly the same state that she was just prior to the previous choice, so that the Born

[1] Here we also need to correct an inaccuracy in the quoted argument by Sider: "quantum mechanics merely says that causes make their effects probable." No, a 'cause' (considered as a quantum state subject to measurement) can give rise to equally possible measurement outcomes. Thus a quantum mechanical 'cause' can set up a number of equally possible effects, none of which is any more probable than the others.

Rule propensities are likely not the same as in the previous instance. Even if the experiment is repeated many times, a resulting set of outcomes in which so many parameters are ill-defined and subject to change has no bearing on whether any particular statistical law is being violated.

Thus, it is a highly nontrivial matter to try to apply the Born Rule to macroscopic biological systems and their macroscopically defined choices; yet Sider's argument for the failure of free choice presumes without argument that one can straightforwardly do so.[1] This may not be possible due to the quickly changing and therefore ill-defined nature of the physical systems constituting the choosing agent during any relevant time interval, and the similarly ill-defined-over-time status of the "choice observable." (And that is to disregard the distinction between microstates and macrostates, where it is probably the latter that correspond to human choices.) Thus it is far from established that there would be any necessary statistical violation of the Born Rule resulting from free choices even if such choices are made possible by fundamental quantum indeterminacy.

Finally, the claim that free will must be anomic and "anti-scientific" also encompasses psychological laws. But the latter are either empirically observed statistical regularities or fallible theoretical models. In either case, no large-scale, apparently deterministic regularity is necessarily inconsistent with fundamental indeterminacy and the attendant possible opening for free will. For example, the Ideal Gas Law, $PV = nRT$, is a large-scale, apparently deterministic statistical effect of microscopic processes and yet does not conflict with fundamental quantum indeterminacy.

Concerning the fallibility of theoretical models of human behavior, and generalizations made from empirical observation: to every rule formulated to 'cover' human behavior, there is an exception. For example, this author recalls the following introductory statement in a college sociology textbook: "Everybody loves a parade." But on the contrary, certainly there are people do not love parades. Does that make their behavior anti-scientific? Perhaps more to the point, is an arbitrary volitional choice–one in which the choosing agent provides no reason or cause for their choose– 'antiscientific'? An affirmative answer to this question seems to be an underlying assumption of the arguments against agent causation. Yet if quantum theory indicates that genuine indeterminism is a feature of the world, then one can point to no reason or cause for an electron to 'choose' spin up over spin down when both are equally likely and equally possible. Yet one such outcome always occurs.[2] And quantum theory is a (set of) well-corroborated scientific law(s). Moreover, since one such outcome does in fact occur, quantum theory might even be seen as *demanding* some sort of

[1] Indeed the idea that macroscopic objects like humans are describable by quantum states, while routinely assumed, is also debatable. In particular this is not the case in the Transactional Interpretation; [6], 112-115.

[2] Here I disregard "many worlds theories" which hold that all outcomes occur, because (as I have argued elsewhere) I think they face serious problems; cf. [7]. I also disregard the "Bohmian" theory because of weaknesses in accounting for the putative corpuscles in the relativistic domain and because of a cogent argument by Brown and Wallace [8] that it amounts to a many-worlds picture.

primitively volitional capacity on the part of quantum systems. In fact, this is not a new idea: physicist Freeman Dyson famously opined that

" ... I think our consciousness is not just a passive epiphenomenon carried along by the chemical events in our brains, but is an active agent forcing the molecular complexes to make choices between one quantum state and another. In other words, mind is already inherent in every electron, and the processes of human consciousness differ only in degree but not in kind from the processes of choice between quantum states which we call "chance" when they are made by electrons." [9], 249

2. Critique of causal notions invoked in support of the alleged lawlessness of free choice

Let us now turn to Sider's claim that we must be somehow "detached" from our choices if they are not considered as caused by our beliefs and/or desires([2], 121). The idea that choices must be attributable to beliefs or desires is questionable in itself, since it does not take into account situations, as alluded to just above, in which we are called upon to make a completely arbitrary choice that does not involve any necessary belief or desire. For example, an experimenter needs to generate some statistics for an experiment on an entangled EPR pair. He stands at one measuring device (a Stern-Gerlach apparatus) and his colleague stands at another. In each run, they must choose an orientation for the S-G magnet, say 'z' or 'x'. They have no belief or desire relevant to making each choice; it is completely arbitrary. Yet there is no logical incompatibility with each of their choices being free, and also connected to themselves as choosing agents.

Thus, there is no necessary 'detachment' in making a completely arbitrary choice. The experimenters make an arbitrary choice because they need to do so in order to conduct the experiment. At most, one might say that they have a 'belief' or 'desire' that they should have roughly the same number of x's and z's, but that does not constitute any belief or desire applying to any individual choice. This is similar to the scenario considered by Clarke in which an agent is given a target distribution and he freely chooses how to approximate that distribution in each individual case.

More generally, a claim such as Sider's concerning the causal relationship between an agent and his or her choice must be based both on specific theories of (i) causation and (ii) the 'Self' that is, on some notion of who or what it is that is to be considered as characterized by beliefs and desires, in what aspect of the Self those beliefs and desires consist, and in what sense the choosing Self is 'detached' from them if they are not subject to the notion of causality invoked in (i). These kinds of details are not provided in support of the claim, and it is far from clear that (apart from the consideration of arbitrary choices as above) it would hold across the board, in the context of all possible theories of causation and its relation to the Self.

Let us first consider (i): causation. I will not attempt to present and defend any particular theory of causation for purposes of this paper, which has a narrow focus on the "anomic" claim. What must be remembered, however, is that causation (as Hume pointed out) is not something that can be grounded empirically. It is never found in the observable world. Rather, causation is a vexed theoretical construct invoked in an attempt to explain the regularities that we see in the world. In particular, it is invoked as a kind of 'missing link' whenever we see that a particular type of input seems always to be followed by a unique type of output.

Since causation is not externally observed, it is certainly possible that it could be an aspect of volition, which (if it exists) is a wholly internal sort of influence. (Does viewing causation as an aspect of volition seem to conflict with the concept of causation as explaining apparently deterministic regularities? Not if it is kept in mind that the *apparent* determinism of the classical realm arises from a fundamental quantum indeterminacy, in the limit of large quantum numbers and/or large numbers of interacting degrees of freedom.) In this case, it would be entirely conceivable to regard the agent as the primary cause of his or her free choice, through an irreducible act of volition. As above, that volition need not be 'caused by' desires or beliefs; it could be invoked to fulfill an arbitrary criterion. This brings us to an appropriately non-detached view of the Self, point (ii): that is, the action can be considered as causally connected to the Self through that primary volitional act.

In this picture, the volitional power is the essence of the *external intervention* whose causal efficacy is crucial to libertarian free will. As incompatibilists correctly note, under strict determinism there is no external intervention in the flow of events. However, quantum theory predicts only a set of outcomes without specifying which of the set will occur; yet one always does. Consider this puzzling fact in light of Curie's Principle, a version of the Principle of Sufficient Reason which says that a specific outcome must always be attributable to a specific cause which actualizes that outcome as opposed to all others. This principle (which may or may not apply to Nature) specifies that the specific cause is a necessary condition for something to happen; absent that specific cause, nothing will actually happen.

If Curie's Principle does in fact apply to Nature, it would appear that some external intervention is actually necessary in order for any of that set of possible events to occur. Were this the case, it would directly rebut the presumption of 'randomness' attributed by Sider to an agent subject at some level to the Born Rule: on the contrary, the choosing agent would use his or her freedom of choice to provide the asymmetric cause demanded by Curie's Principle. (But even if Curie's Principle does not strictly apply to Nature at the quantum level, there is certainly room, in-principle, for the agent to 'tip the scales' for one outcome as opposed to the others.)

3. Conclusion

This paper has focused on two specific critiques of libertarian, agent-causal free will: (i) the claim that it must be anomic or "antiscientific"; and (ii) that it must be causally detached from the choosing agent. The present author is aware that the topic of volitional agent causation is a deep and vexed issue with a very lengthy literature. This paper does not address the broader concerns; its primary intent is to point out that the grounds often adduced for claiming that agent causation is inconsistent with 'our best scientific theories' [10] are weak, based as they are on misunderstandings (or at best, unsupported assumptions) concerning the nature and applicability of the quantum probability law to human choices. For example, O'Connor [11] discusses Pereboom's criticism that agent causation is (in O'Connor's terms) "inconsistent with seeing human beings as part of the natural world of cause and effect." But this statement and its attendant critiques of agent-causal free will presuppose a particular metaphysical view of the 'natural world' that excludes quantum indeterminism. Or, if quantum processes are (however cursorily) considered as part of the natural world, the quantum probability law is presumed (without argument and likely erroneously, as argued herein) to apply to human beings and their choices as being describable by well-defined, stable-over-time quantum states and eigenvalues of observables, respectively. Thus, the treatment of quantum theory in connection with free will has been considerably less careful than would warrant sweeping negative conclusions about its compatibility with processes in the natural world.

Moreover, the puzzle of indeterministic, seemingly uncaused 'collapse' to one outcome from a set of eligible outcomes seems to beg for an external intervention of some sort, in order to satisfy Curie's Principle. It might seem farfetched to think of quantum objects such as electrons or photons as having volition, yet it is certainly conceivable that some very primitive and elementary form of volition might obtain at this level. While volition is a conscious mental function, some of the quantum pioneers thought of the quantum domain as mental, or at least idea-like, in nature (for example, Heisenberg's non-actual 'potentiae' ([12] 154-5). Pauli remarked that the quantum process of actualization of events "acausally weaves meaning into the fabric of nature." [13]. Clearly, 'meaning' is something that arises from the mental realm, not from inanimate material systems.

Considering the elementary constituents of matter as imbued with even the minutest propensity for volition would, at least in principle, allow the possibility of a natural emergence of increasingly efficacious agent volition as the organisms composed by them became more complex, culminating in a human being. And allowing for volitional causal agency to enter, in principle, at the quantum level would resolve a very puzzling aspect of the indeterminacy of the quantum laws–the seeming violation of Curie's Principle in which an outcome occurs for no reason at all. This suggests that, rather than bearing against free will, the quantum laws could be the ideal nomic setting for agent-causal free will.

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